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CARDIO-PROTECTIVE EVALUATION OF ETHANOL LEAF-EXTRACT OF COCOYAM (*Colocasia esculenta*) ON SALBUTAMOL-INDUCED MYOCARDIAL INJURY IN WISTAR RATS

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ABSTRACT

This study evaluated the possible cardio-protective effect of ethanol leaf-extract of cocoyam (Colocasia esculenta) on salbutamol-induced myocardial injury in adult Wistar rats. Thirty rats weighing 100g-120g were distributed into 6 groups. Control groups (1-3) received 10ml/kg b.wt water (normal), 80mg/kg b.wt salbutamol for 2 days (negative), and salbutamol plus 10mg/kg b.wt propranolol for 10 days (positive) respectively. Test groups (4-6) received the extract (200, 400 and 800mg/kg b.wt respectively) for 28 days and salbutamol for 2 days. The administration was oral. The animals were sacrificed and blood samples were collected for biochemical analysis. The hearts were harvested for antioxidant analysis and histopathological studies. The results showed that troponin I and creatinine kinase-MB (CK-MB) were significantly elevated ($p<0.05$) in group 2 but reduced ($p<0.05$) in groups 4-6. Reduced glutathione (GSH), catalase (CAT) and superoxide dismutase (SOD) significantly reduced ($p<0.05$) while malondialdehyde (MDA) significantly increased ($p<0.05$) in group 2 but CAT and SOD increased significantly ($p<0.05$) while MDA decreased significantly ($p<0.05$) in group 4. Total cholesterol (TC), triglycerides (TG), low-density lipoprotein (LDL) and very low-density lipoprotein (VLDL) increased significantly ($p<0.05$), while high-density lipoprotein (HDL) reduced significantly ($p<0.05$) in group 2. A significant ($p<0.05$) reduction was recorded in TG, LDL, and VLDL, and an increase in HDL in group 4. Heart photomicrograph revealed histologically distorted heart tissue in group 2, but histologically normal heart tissue in groups 4-6. The findings in this study suggest that the extract could serve as a cardio-protective agent in salbutamol-induced myocardial injury in adult Wistar rats.

Keywords: Cardio-protection; ethanol leaf-extract; *Colocasia esculenta*; salbutamol; myocardial injury; Wistar rats.

INTRODUCTION

The world's leading cause of mortality has been identified as cardiovascular diseases (CVDs). Approximately 17.9 million deaths are caused by them each year (Shi et al., 2016). It is estimated that mortality related to CVDs will account for 23.3 million deaths by 2030 (Upaganlawar et al., 2011). CVDs are a group of illnesses that affect the heart and the arteries. Atherosclerosis, or plaque in the artery wall, is the underlying pathology of CVDs, which grows over many years and

would have advanced when symptoms arise (WHO, 2007). They also relate to damage of the blood vessels in the vital organs of the body like the heart, kidneys, brain and the eyes. One kind of CVD is myocardial injury, a broad term for the increase in cardiac troponin (cTn) volume when it is above the 99th percentile upper reference limit (URL) with at least one value. Myocardial injury can be classified into acute or chronic myocardial injury based on changes in cardiac troponin concentration (Thygesen et al., 2018). Cardiac troponin (cTn) level rises and falls in acute myocardial injury, while it rises persistently with consecutive measurements in chronic myocardial injury (Hanumantha, 2020).

Therapeutic plants are essential globally in meeting people's healthcare needs. This is because traditional medicines are affordable and accessible. Therefore, people throughout Africa, Asia and Latin America utilize them to meet their primary healthcare needs (Olatunji and Ogunka-Nnoka, 2019). Several parts of medicinal plants like the leaf, root, seeds, flowers, fruit, and stem bark are used in traditional medicine. This is connected to the presence of active substances, called phytochemicals, found in many parts of therapeutic plants that have been described to have medicinal properties that could be used for healing purposes (Oladele et al., 2011). These phytochemicals are derived from medicinal plants, vegetables, and fruits. The plants with cardioprotective potentials have been reported to comprise many of these bioactive substances, which include catechin, diosgenin, sulforaphane, isoflavones, carotinized, and quercetin, which have been proven to be effective in minimizing the danger of cardiac anomalies (Syed et al., 2019).

Colocasia esculenta, generally known as cocoyam, is a plant that is known as a possible therapeutic plant. Many parts of the plant are used to treat many diseases traditionally. It is a green leafy vegetable which is rich in microminerals like iron, potassium, zinc etc., and also has a high content of proteins, carbohydrates, and vitamins (Smriti et al., 2020). *C. esculenta* is usually grown in humid regions and it is a part of the genus *Colocasia* that belongs to the *Araceae* plant family. It can be cultivated as an ornamental plant, medicinal plant, root crop, and leafy vegetable. It has also been reported to contain manganese, thiamine, iron, riboflavin, phosphorus, vitamin C, vitamin B6, niacin, copper, and potassium (Rashmi et al., 2018). *C. esculenta* leaf is rich in phytochemicals like alkaloids, flavonoids, glycosides, terpenoids, oxalates, saponins, phenols etc. These could explain why it has many therapeutic uses like management of heart injury, averting oxidative stress, ameliorating headaches, etc. (Amit et al., 2019). The aqueous extracts of *C. esculenta* leaves have been reported not to cause toxic effects on experimental animals for 28 days at doses lower than 1000 mg/kg b.wt (Azubike et al., 2016).

Salbutamol is a medication for relaxing and decongesting respiratory airways. It can ease wheezing, chest tightness, coughing, and breathlessness in asthmatic and chronic obstructive pulmonary disease (COPD), including emphysema and chronic bronchitis. Salbutamol is sold under the brand name Ventolin (Thornton, 2023). Salbutamol is a synthetic catecholamine, which shares a similar structure and mode of action with isoproterenol, the overdose of which brings about severe myocardium stress and necrosis (Aslam et al., 2015). Catecholamine, when given at high doses, can induce myocardial damage, which can cause hypoxia, ischemia, coronary hypertension and myocardial hyperactivity (Beaulah et al., 2014).

Presently, available synthetic drugs for cardio-protection are costly and have been noted for several side effects. Meanwhile, medicinal plants have been very accessible, and affordable and have fewer side effects comparatively, which has made them more attractive alternative medicines (Olatunji and Ogunka-Nnoka, 2019). Many medicinal plants have been reported to be very effective as alternative medicines for cardiac anomalies

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but the cardioprotective potentials of cocoyam (*Colocasia esculenta*) leaves, a therapeutic plant used in the treatment of several ailments, are yet to be properly investigated. Therefore, this study was carried out to evaluate the possible cardio-protective effects of the ethanol leaf extract of cocoyam (*Colocasia esculenta*) on salbutamol-induced myocardial injury in adult Wistar rats.

Figure1:*ColocasiaEsculenta* leaves
Source: Colocasia esculenta (Taro) (gardenia.net) (retrieved February 4, 2024)

MATERIALS AND METHODS

Plant sample collection

The cocoyam (*Colocasia esculenta*) leaves were sourced from the University of Port Harcourt, Rivers State campus environment in July 2023. The leaves sample was identified and validated using a standard voucher (UPH/P/377) preserved in the herbarium section of the Plant Science department, University of Port Harcourt.

Experimental animals

Thirty (30) Wistar adult rats that weigh 100g to 120g were utilized for this study. They were kept and allowed to acclimatize in the animal house of the Pharmacology Department, University of Port Harcourt, Rivers State, Nigeria for 7 days under standard atmospheric conditions. During this time, the animals were fed and given water *ad libitum*. Salbutamol, propranolol, and the ethanol extract of *Colocasia esculenta* leaves were administered based on the experimental design. The authors collected and preserved written ethical approval in line with the international standards or university guidelines with the reference number UPH/CEREMAD/REC/MM89/056.

Preparation of plant sample and Extraction

The leaves were washed thoroughly with distilled water, cut into pieces and dried for two weeks at room temperature. The dried leaves were milled to powder using an electric grinder and the powdered leaves were measured by digital balance and eight hundred grams of powdered sample was obtained. Sample extraction was performed using the maceration extraction method of

Majekodunmi (2015). The powdered sample was macerated at room temperature, in 5L of 95% ethanol, for 72 hours. The content was occasionally stimulated to make extraction complete. The micelle (the mixture of the extract and the extraction solvent) was separated from the marc (an insoluble extract material) by filtration. The solvent was removed from the extract with a rotary vacuum evaporator below 40 degrees Celsius at reduced pressure. The extracts were collected and refrigerated at 4 degrees Celsius pending their use for the experiment. The percentage yield of the extract was 7.6% determined by the method of Zhang et al. (2007).

Experimental Design

The animals were randomly and evenly categorized into groups 1 to 6 of five (5) animals per group.

Table 1: Experimental design for the Evaluation of the effects of the ethanol extract

Group	Treatment
Group 1 (Normal Control)	Distilled water (10mL/kgb.wt/ day) only
Group 2 (Negative Control)	80 mg/kgb.wt salbutamol for 2 days
Group 3 (Positive Control)	80 mg/kgb.wt salbutamol for 2 days + 10mg/ kg b.wt propranolol for 10 days
Group 4	200mg/kgb.wtof extract for 28 days + 80 mg/kg b.wt salbutamol for 2 days
Group 5	400mg/kgb.wtof extract for 28 days + 80 mg/kg b.wt salbutamol for 2 days
Group 6	800mg/kgb.wtof extract for 28 days + 80 mg/kg b.wt salbutamol for 2 days

Collection of Blood and Tissue Organs for Analysis

The animals were sacrificed after a simple anaesthesia (using chloroform), and blood was collected from them. The blood samples were kept in plain bottles to coagulate, centrifuged at 3,000rpm for 15minutes, and used for biochemical analyses. Serum was collected for cardiac biomarkers analysis (Troponin I, CK-MB, and LDH) and Lipid profile. The animals were dissected and the hearts were removed and weighed using a digital balance. A portion of the hearts were kept in 0.9% normal saline water in plain bottles for antioxidant analysis, the remainder were stored in plain bottles in 10% formalin for histopathological studies.

Histological Examination

The method suggested by Kumar et al. (2000) was used for heart histological analysis.

Statistical Analysis

Statistical Package for Social Science (IBM-SPSS version 26) was used to analyze the results. Significant differences between the control groups and the treatment groups were arrived at using a one-way analysis of variance (ANOVA). The values were reported as means ± standard deviation, and a probability value of less than 5% ($p<0.05$) was termed significant and vice versa.

RESULTS

The effect of the extract on cardiac biomarkers

The effect of the extract on cardiac bio-markers of rats induced with myocardial injury using salbutamol is presented in Table 2. Salbutamol significantly ($p<0.05$) increased the level of serum cardiac markers (Troponin I and CK-MB), and slightly increased the LDH in group 2 when compared to group 1. The standard drug (group 3) brought about a

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significant ($p<0.05$) reduction in LDH and a slight decrease in Troponin I and CK-MB when compared to group 2. However, the extract at all the doses in groups 4-6 caused a significant ($p<0.05$) difference in Troponin I, CK-MB and LDH compared to group 2.

The effect of the extract on the oxidative stress markers

The effect of the extract on oxidative stress markers of rats induced with myocardial injury using salbutamol is presented in Table 3. There was a significant ($p<0.05$) decline in the level of GSH, CAT and SOD levels, and a significant ($p<0.05$) increase in the activities of MDA in salbutamol-treated animals (group 2) as compared to untreated animals (group 1). The standard drug (group 3) was only effective in restoring the SOD and MDA significantly ($p<0.05$), with no significant difference in GSH and CAT. The extract at 200mg/kg b.wt (group 4) caused a slight increase in GSH while there was a significant ($p<0.05$) increase in CAT, SOD and a significant ($p<0.05$) decrease in MDA levels when compared with group 2. The 400 and 800mg/kg b.wt of the extract caused a significant ($p<0.05$) increase in the SOD and a significant ($p<0.05$) decrease in MDA and a slight increase in CAT and GSH when compared to group 2.

The effect of the extract on lipid profile

The effect of the extract on the lipid profile of rats induced with myocardial injury using salbutamol is presented in Table 4. Salbutamol significantly altered the lipid profile in group 2 as it caused a significant ($p<0.05$) increase in TC, TG, LDL and VLDL, and a reduction in HDL when compared to group 1. The standard drug (group 3) restored all the lipid profile indices, except HDL significantly ($p<0.05$) when compared to group 2. The extract at 200mg/kg b.wt (group 4) significantly ($p<0.05$) reduced TG, LDL, and VLDL, and significantly ($p<0.05$) increased HDL when compared to group 2 but caused no significant difference in TC. At 400mg/kg b.wt (group 5), the extract had no significant difference on all the indices of the lipid profile when compared with group 2. But the extract at 800mg/kg b.wt (group 6) caused a significant ($p<0.05$) increase in HDL while its effect on TC, TG, LDL, and VLDL are insignificant when compared with group 2.

Table 2: The effect of the extract on cardiac biomarkers

GROUP	TropI (ng/ml)	CK-MB (ng/ml)	LDH (u/l)
Group 1	0.17 ± 0.05^{b}	0.89 ± 0.04^{b}	23.64 ± 0.92
Group 2	0.89 ± 0.48^{a}	2.48 ± 0.92^{a}	27.34 ± 1.18
Group 3	0.48 ± 0.03	2.19 ± 0.01	14.60 ± 1.15^{b}
Group 4	0.22 ± 0.06^{b}	0.93 ± 0.11^{b}	16.50 ± 1.93^{b}
Group 5	0.45 ± 0.06^{b}	1.39 ± 0.15^{b}	18.18 ± 3.05^{b}
Group 6	0.38 ± 0.05^{b}	1.19 ± 0.03^{b}	17.28 ± 0.72^{b}

Values represent Mean ± Standard Deviation, n=5. Superscript 'a' signifies a significant difference from normal control (group 1) at ($p<0.05$); Superscript 'b' signifies a significant difference from negative control (group 2) at ($p<0.05$). TropI = Troponin I, CK-MB = Creatinine Kinase-MB, LDH = Lactate Dehydrogenase.

Table 3: The effect of the extract on oxidative stress markers

GROUP	GSH (u/ml)	CAT (u/g)	SOD (u/ml/l)	MDA (µmolml)
Group 1	1.33 ± 0.07^{b}	1.12 ± 0.22^{b}	0.32 ± 0.01^{b}	0.44 ± 0.03^{b}
Group 2	0.84 ± 0.13^{a}	0.46 ± 0.09^{a}	0.20 ± 0.02^{a}	0.60 ± 0.04^{a}
Group 3	1.03 ± 0.10	0.79 ± 0.06	0.33 ± 0.02^{b}	0.41 ± 0.01^{b}

Group 4	1.05±0.23	1.00±0.22[b]	0.45±0.07[b]	0.34±0.13[b]
Group 5	1.02±0.14	0.75±0.06	0.30±0.01[b]	0.45±0.02[b]
Group 6	1.03±0.08	0.74±0.15	0.56±0.04[b]	0.23±0.07[b]

Values represent Mean ± Standard Deviation, n=5. Superscript 'a' signifies a significant difference from normal control (group 1) at ($p<0.05$); Superscript 'b' signifies a significant difference from negative control (group 2) at ($p<0.05$). GSH = Reduced Glutathione, CAT = Catalase, SOD = Superoxide Dismutase, and MDA = Malondialdehyde.

Table 4: The effect of the extract on lipid profile

GROUP	TC (µmol/l)	TG (µmol/l)	HDL (µmol/l)	LDL (µmol/l)	VLDL (µmol/l)
Group 1	2.16±0.09[b]	1.06±0.05[b]	1.65±0.09[b]	0.99±0.08[b]	0.48±0.02[b]
Group 2	2.80±0.14[a]	1.21±0.05[a]	1.10±0.06[a]	1.91±0.21[a]	0.55±0.02[a]
Group 3	1.93±0.03[b]	1.09±0.01[b]	1.30±0.26	1.12±0.23[b]	0.49±0.01[b]
Group 4	2.61±0.08	0.83±0.02[b]	1.77±0.66[b]	1.22±0.03[b]	0.38±0.01[b]
Group 5	3.28±0.12	1.25±0.02	1.46±0.22	2.38±0.10	0.57±0.01
Group 6	3.18±0.05	1.38±0.02	1.66±0.01[b]	2.13±0.04	0.63±0.01

Values represent Mean ± Standard Deviation, n=5. Superscript 'a' signifies a significant difference from normal control (group 1) at ($p<0.05$); Superscript 'b' signifies a significant difference from negative control (group 2) at ($p<0.05$). TC = Total Cholesterol, TG = Triglycerides, HDL = High-Density Lipoprotein, LDL = Low-Density Lipoprotein, and VLDL = Very Low-Density Lipoprotein.

Histopathological Results on the Heart

Histopathological study revealed that the control group showed histologically normal heart tissue. However, the negative control group showed histologically distorted heart tissue with hyalinization (Hl) of myofibrils. The examination of the positive control group revealed histologically regenerated heart tissue. Meanwhile, the protective groups showed histologically normal heart tissue showing central nuclei (NU), and cardiac myofibrils (MF); that branched, weaved and re-united forming a network.

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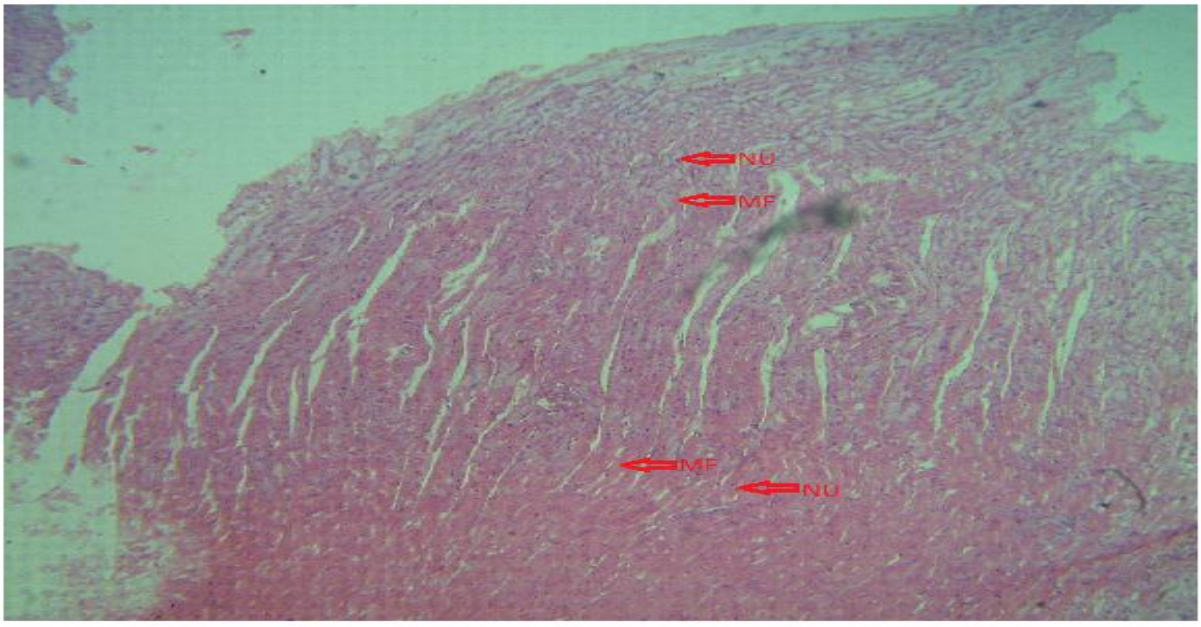

Plate 1: Photomicrograph of a longitudinal section of Cardiac Muscle, Mag. X 100 H&E, from the normal control group (group 1). This showed histologically normal heart tissue with central nuclei (NU), and cardiac myofibrils (MF); branched, weaved and re-united forming a network.

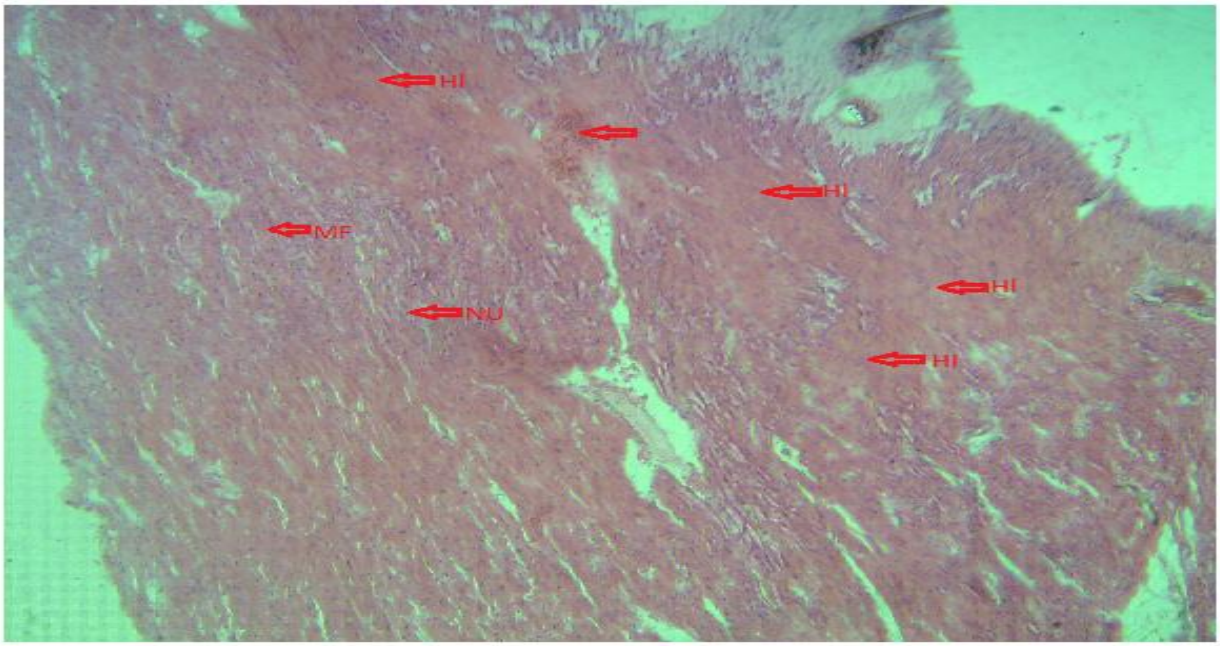

Plate 2: Photomicrograph of a longitudinal section of Cardiac Muscle, Mag. X 100 H&E from the negative control group (Group 2). The findings showed histologically distorted heart tissue with central nuclei (NU), and cardiac myofibrils (MF); branched, weaved and re-united forming a network but with hyalinization (Hl) of myofibrils.

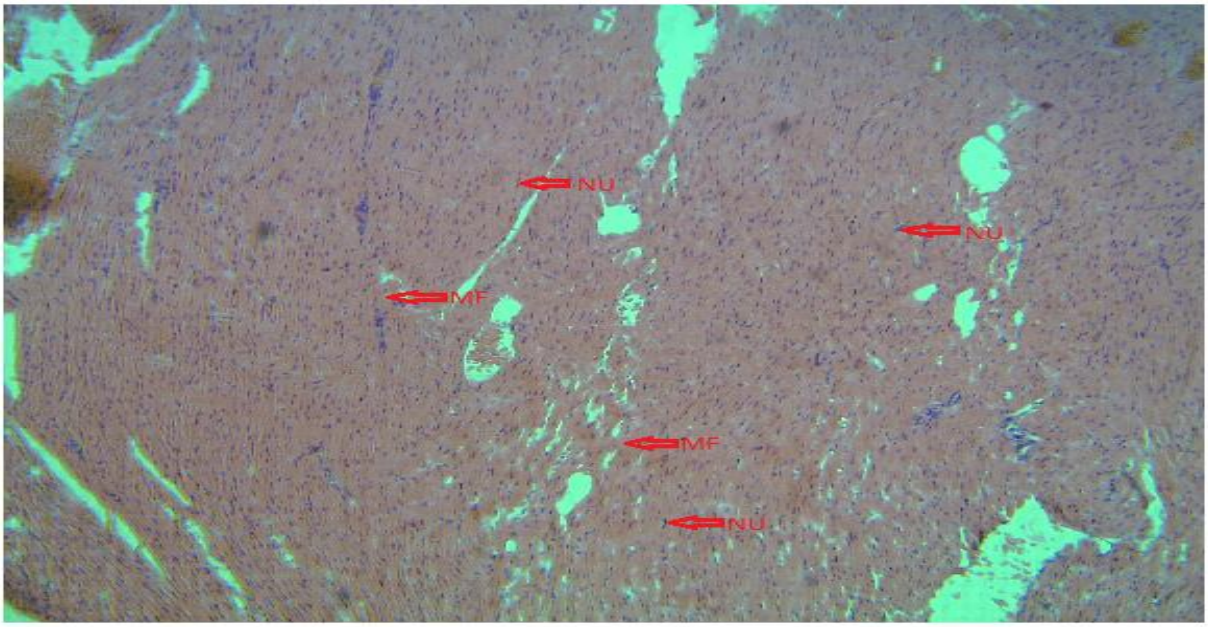

Plate 3: Photomicrograph of a longitudinal section of Cardiac Muscle, Mag. X 100 H&E from the positive control group (group 3). This revealed histologically regenerated heart tissue with central nuclei (NU), and cardiac myofibrils (MF); branched, weaved and re-united forming a network.

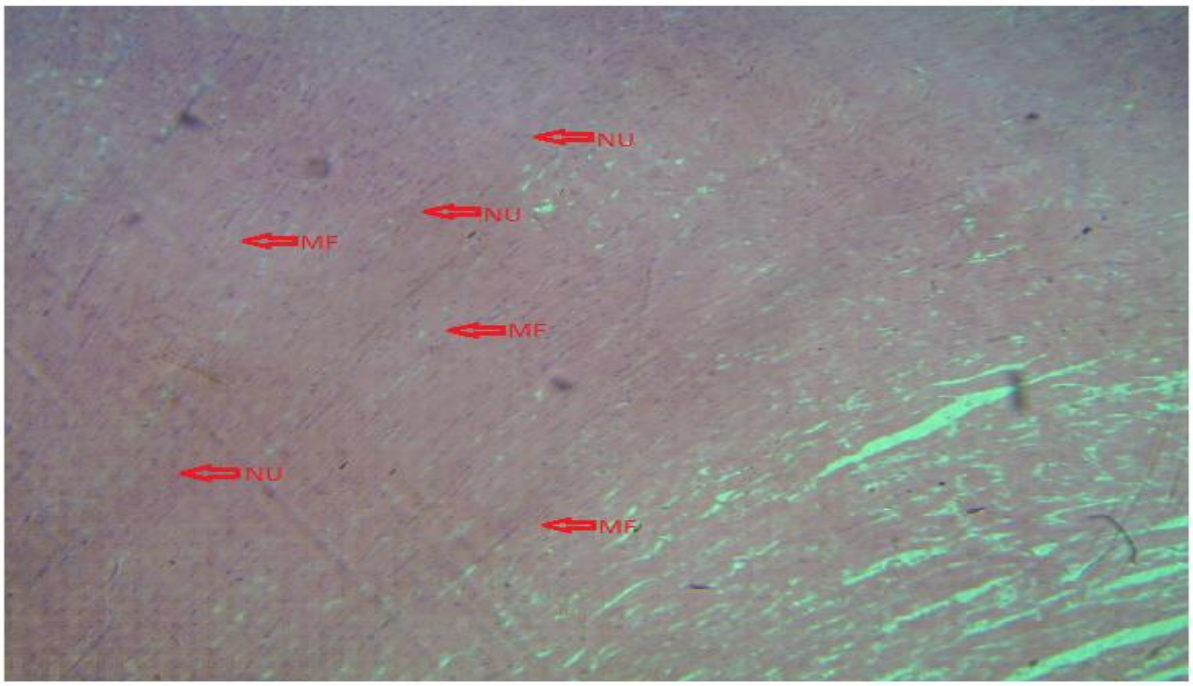

Plate 4: Photomicrograph of a longitudinal section of Cardiac Muscle, Mag. X 100 H&E from group 4 (200 mg/kg b. wt). The findings showed histologically normal heart tissue showing central nuclei (NU), and cardiac myofibrils (MF); branched, weaved and re-united forming a network.

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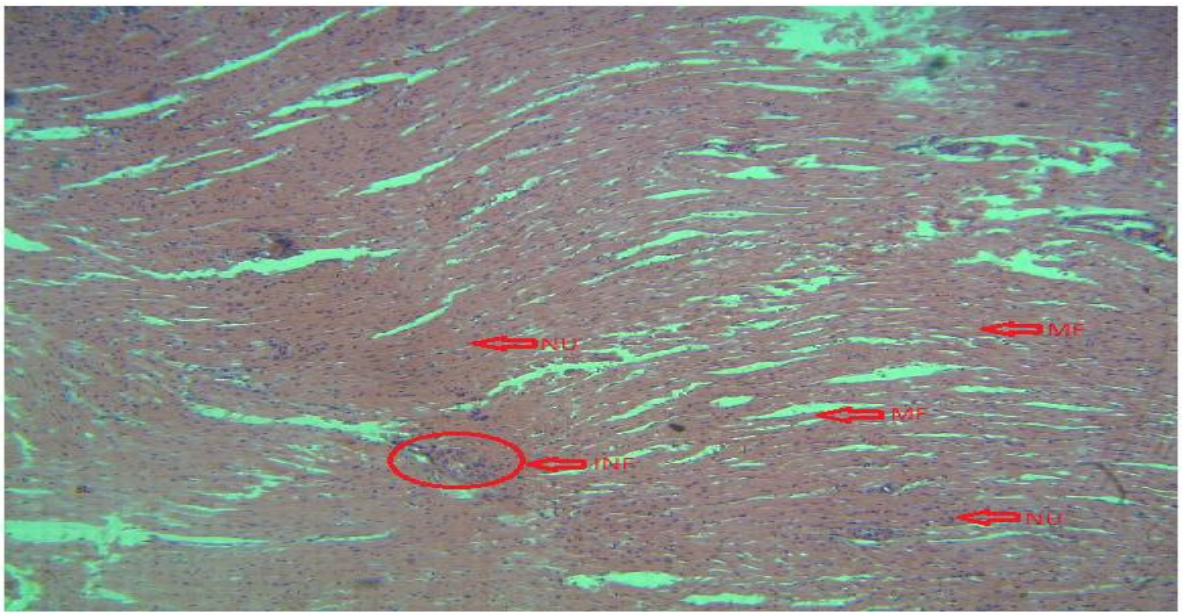

Plate 5: Photomicrograph of a longitudinal section of Cardiac Muscle, Mag. X 100 H&E from group 5 (400 mg/kg b. wt). The findings revealed histologically normal heart tissue showing central nuclei (NU), and cardiac myofibrils (MF); branched, weaved and re-united forming a network.

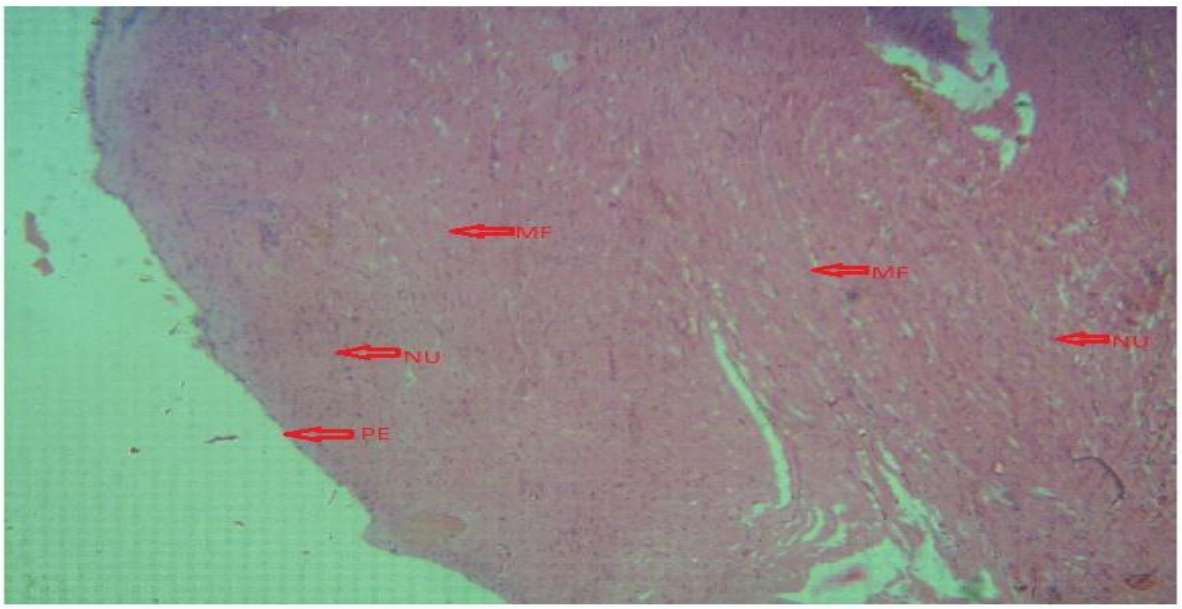

Plate 6: Photomicrograph of a longitudinal section of Cardiac Muscle, Mag. X 100 H&E from group 6 (800 mg/kg b. wt). The result showed a histologically normal heart tissue with central nuclei (NU), cardiac myofibrils (MF); branched, weaved and re-united forming a network, and pericardium (PE).

DISCUSSION

The impacts of medicinal plants on health care in developing countries are enormous because many people in such countries still depend on their use for therapeutic purposes (Oladele et al., 2011). Moreso, medicinal plants have been used to treat various diseases from the inception of human existence till date. This study evaluated the possible cardio-protective effect of the ethanol leaf extract of cocoyam (*Colocasia esculenta*) on salbutamol-induced myocardial injury in adult Wistar rats.

Cardiac biomarkers are substances that leak into the bloodstream when there is damage to

the heart muscle (Jacob and Khan, 2018). A cardiac troponin test is the major test for examining patients suspected to have myocardial injury. There are three troponins in the contractile component of the myocardium, but two of them, troponin-I and troponin-T, are commonly used to establish the presence of myocardial injury. This is because both are highly specific and sensitive to myocardial damage (Sharma et al., 2004). In this study, the salbutamol-treated rats showed significant elevation of Troponin I (cTnI) and CK-MB levels. The LDH was also slightly elevated by the salbutamol. The significant elevation of the cTnI and CK-MB is a pointer to damage to the heart muscle. This result corroborates the findings of Zafar et al. (2015), who stated that an elevation was seen in cardiac enzyme levels (CK-MB, LDH, AST, and ALT) in salbutamol-induced animals as compared to animals of the normal control group. Salbutamol overdose caused a significant increase in serum CK-MB and cTnI levels due to their leakage from the damaged myocardial cell membrane into the bloodstream when there is myocardial necrosis (Beaulah et al., 2014). Meanwhile, the ethanol extract at all the doses (200, 400 and 800mg/kg b.wt) maintained normal levels of Troponin I, CK-MB and LDH when compared to the salbutamol group. These results imply that the pre-treatment of the extract was able to control the leakage of cTnI and CK-MB from the myocardium into the blood by maintaining cardiac membrane structure and functionality.

Oxidative stress markers are used to evaluate the disease status and the therapeutic potentials of antioxidants. Antioxidant systems obstruct the uncontrolled production of oxidants and activate oxygen species, or avert their reactions with biological structures (Riley, 1994). In this work, the level of GSH, CAT and SOD activities declined significantly, while MDA activities increased significantly in salbutamol-treated animals (group 2) as compared to untreated animals (group 1). Aslam et al. (2015) corroborated this result as they reported a significant decrease in all antioxidant enzymes when the normal control group is compared with the salbutamol group. The current work showed that the pre-treatment with the extract maintained normal levels of SOD, CAT and GSH and MDA in the experimental animals when compared with their levels in the salbutamol-induced rats. However, the effects of the extract were discovered to be dose-dependent as 200mg/kg b.wt dose of the extract significantly maintained the levels of CAT, SOD and MDA. While the 400 and 800mg/kg b.wt of the extract were also able to maintain the levels of only the SOD and MDA significantly. Aslam et al. (2015) also supported the result of this work as they reported that an herbal mixture has the potential to restore the antioxidant enzyme activities depleted by salbutamol. In the present study, therefore, the extracts preserved the normal levels of SOD, CAT, GSH and MDA. The effect of the extract could be due to the presence of phytochemicals, like tannins, quercetin, protocatechuic acid, and kaempferol derivatives. Especially tannins, such as gallo tannin, which have hydroxyl molecules that scavenge free radicals (Park et al., 2019).

The role of Lipids is essential in CVDs. They help to alter the structure, composition and stability of the cellular membrane and in the buildup of atherosclerosis (Khalil et al., 2015). In this work, salbutamol significantly altered the lipid profile in group 2 as it caused a significant increase in TC, TG, LDL and VLDL, and a significant reduction in HDL (good cholesterol) when compared to group 1. Zafar et al. (2015) also reported significantly elevated levels of TC, TG, and LDL in salbutamol-induced animals, indicating salbutamol-induced hyperlipidemia. The ethanol extract at 200mg/kg b.wt maintained normal levels of TG, LDL, VLDL, and HDL when compared to group 2, but had no significant effect on TC. The other doses (400 and 800mg/kg b.wt) were not very effective in protecting the levels of the lipids against salbutamol overdose. This result agrees with Bopda et al. (2018) who stated that pre-

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treatment of animals with 100 mg/kg b.wt of *K. pinnata* extract will lead toa decline in the cholesterol level in the serum of isoprenaline-treated rats. This effect must have been connected to the presence of phenols in *C. esculenta* leaf extracts (Krishnapriya & Suganthi, 2017). Meanwhile, polyphenols have been reported to prevent cholesterol esterase by Ngamukote et al. (2011). This is because polyphenols like flavonoids permanently bind with the enzyme in its active pocket at serine 194. The effective prevention is due to the ability of flavonoids to act as substrate ahead of cholesterol esters (Kumar et al., 2000).

Histopathological examination is normally undertaken to determine specific microscopic structural changes in diseased organ tissue (Olatunji & Ogunka-Nnoka, 2019). Therefore, a histopathological study was performed in this work to establish a comprehensive view of the myocardial tissue architecture of salbutamol-induced myocardial injury in rats treated with ethanol extract of *C. esculenta* leaves. The results revealed that the normal control group showed histologically normal heart tissue. Meanwhile, the negative control group (salbutamol) showed histologically distorted heart tissue with hyalinization (Hl) of myofibrils. Aslam et al. (2015) corroborated this result. They noted that histopathological examination of the heart of normal control animals revealed that the myocardial cell membrane was intact. However negative control (salbutamol-treated animals) showed degenerated heart tissue. Meanwhile, all the extract groups showed histologically normal heart tissue showing central nuclei (NU), and cardiac myofibrils (MF); branched, weaved and re-united forming a network. This result is similar to the report of Sajid et al. (2022) who noted that pretreated groups of animals with *F. indica* extract (100 mg/kg) showed regenerated heart tissue. Therefore, the results of the present work revealed that the plant extract is potent at various concentrations in protecting the integrity of heart tissue against salbutamol overdose.

CONCLUSIONS

This study clearly shows that the ethanol leaf extract of cocoyam (*Colocasia esculenta*) prevented the effect of salbutamol overdose on cardiac biomarkers, oxidative stress markers, lipid profile, haematological indices, and histological alterations in adult Wistar rats. The study therefore suggests that the plant could serve as a potent cardio-protective herbal agent in myocardial injury.

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